DOCUMENT RESUME

ED 100 698 88 SE 018 596

TITLE Physics, Environmental Education Guide.
INSTITUTION Project I-C-E, Green Bay, Wis.
SPONS AGENCY Bureau of Elementary and Secondary Education (DHEW/OE), Washington, D.C.; Wisconsin State Dept. of Public Instruction, Madison.
PUB DATE [74]
NOTE 45p.

EDRS PRICE MF-$0.75 HC-$1.85 PLUS POSTAGE
DESCRIPTORS Conservation Education; *Environmental Education; Instructional Materials; Interdisciplinary Approach; Learning Activities; Natural Resources; Outdoor Education; *Physics; *Science Education; *Secondary School Science; *Teaching Guides
IDENTIFIERS Elementary Secondary Education Act Title III; ESEA Title III; Instruction Curriculum Environment; *Project I C E

ABSTRACT

This physics guide, for use at the senior high level, is one of a series of guides, K-12, that were developed by teachers to help introduce environmental education into the total curriculum. The guides are supplementary in design, containing a series of episodes (minilessons) that focus on student-centered activities with direct application of mathematical and physical laws to modern-day technology. The episodes are built around 12 major environmental concepts that form a framework for each grade or subject area, as well as for the entire K-12 program. Although the same concepts are used throughout the K-12 program, emphasis is placed on different aspects of each concept at different grade levels or in different subject areas. This guide focuses on aspects such as mechanics, momentum, and light. The 12 concepts are covered in one of the episodes contained in the guide. Further, each episode offers subject area integration, subject area activities, interdisciplinary activities, cognitive and affective behavioral objectives, and suggested references and resource materials useful to teachers and students. (Author/TK)

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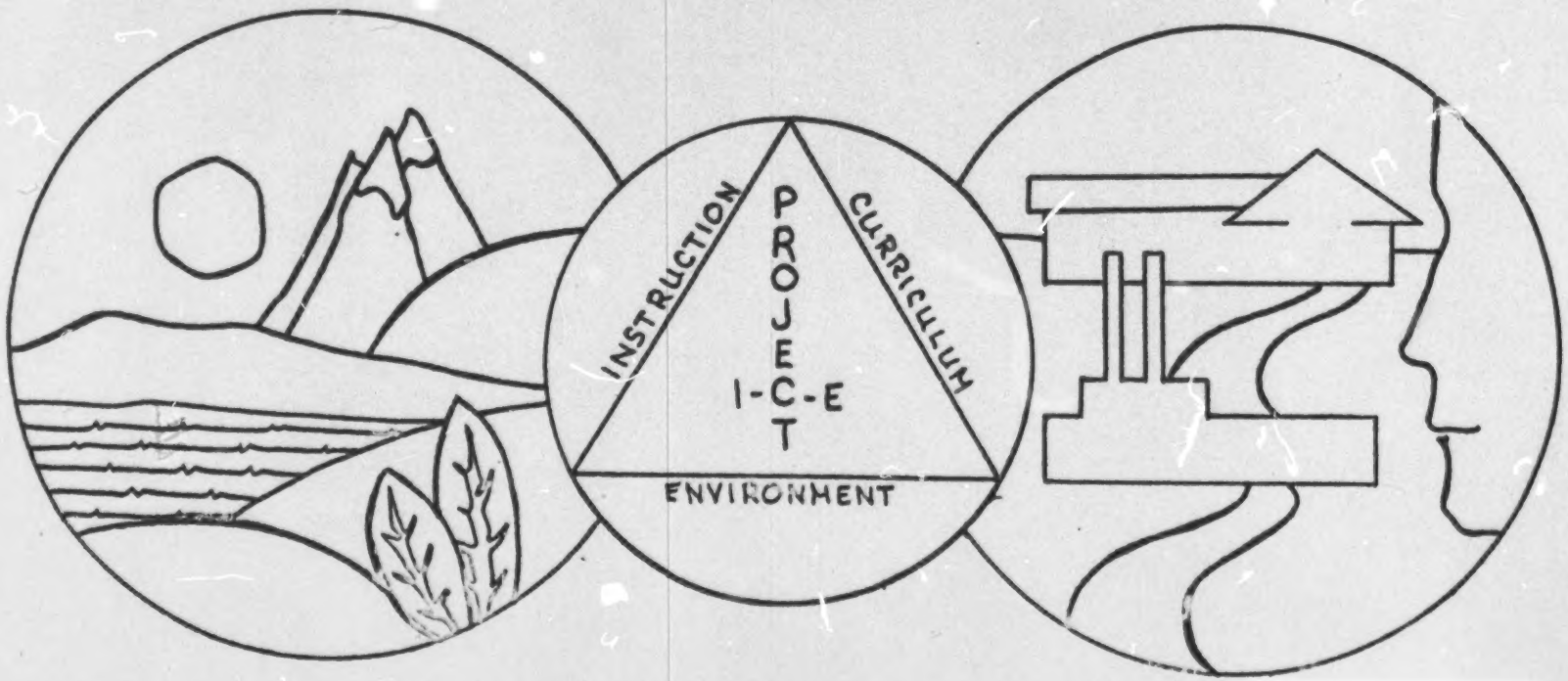
ENVIRONMENTAL EDUCATION GUIDE



PHYSICS

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These materials were produced pursuant
to a grant under Title III, E.S.E.A.
The Wisconsin Department of Public Instruction
Project No. 59-70-0135-4

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FORWARD TO PROJECT I-C-E ENVIRONMENTAL EDUCATION GUIDES

In 1969, the First Environmental Quality Education Act was proposed in the United States Congress. At the time of the introduction of that legislation, I stated:

"There is a dire need to improve the understanding by Americans of the ominous deterioration of the Nation's environment and the increasing threat of irreversible ecological catastrophe. We must all become stewards for the preservation of life on our resource-deficient planet."

In the three years since the Environmental Education Act was passed by the Congress, much has happened in the United States to reinforce the great need for effective environmental education for the Nation's young people. The intensive concern over adequate energy resources, the continuing degradation of our air and water, and the discussion over the economic costs of the war against pollution have all brought the question of the environmental quality of this nation to a concern not merely of aesthetics but of the survival of the human race.

The intense interest by the public in the quality of our lives as affected by the environment clearly indicates that we cannot just use incentives and prescriptions to industry and other sources of pollution. That is necessary, but not sufficient." The race between education and catastrophe can be won by education if we marshall our resources in a systematic manner and squarely confront the long-term approach to saving our environment through the process of education.

As the incessant conqueror of nature, we must reexamine our place and role. Our world is no longer an endless frontier. We constantly are feeling the backlash from many of our ill-conceived efforts to achieve progress.

Rachel Carson's theme of "reverence for life" is becoming less mystical and of more substance as our eyes are opened to much of the havoc we have wrought under the guise of progress. A strong commitment to an all-embracing program of environmental education will help us to find that new working definition of progress that is a pre-requisite to the continued presence of life on this planet.

- Senator Gaylord Nelson

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PHYSICS PREFACE

Concern for preservation and wise use of the environment are necessary if the student is to function as a responsible individual in our society. Physics students possess the tools and background which enable them to examine environmental problems on a more rigorous level than the general populace.

Graduation will place many of these people into decision-making situations in terms of voting, occupational and recreational activities. As a young adult, the senior high school student is interested in learning the facts concerning life in his environment and in implementing correctional measures.

Environmental education is necessarily a scientific problem. Fortunately, educators are incorporating suitable material into the science curricula. This booklet utilizes physics to gain new and deeper understandings of ecology.

Student-centered activities are emphasized throughout the program. The problem of air pollution, for example, is explored by having students construct a model smoke precipitator. The device is connected to a Van de Graff generator and its use demonstrated by collecting smoke particles from burning wood or some other source.

A physics class then is an appropriate place to study the environment because of the direct application of mathematical and physical laws to modern-day technology. This supplemental booklet will allow the physics teacher to incorporate environmental education into his students' course of study.

ACKNOWLEDGEMENT

The interest and dedicated effort of the following teachers from Wisconsin Area "B" has led to the development of the Project I-C-E Environmental Education K-12 series:

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DIRECTIONS FOR USING THIS GUIDE

This guide contains a series of episodes (mini-lesson plans), each containing a number of suggested in and out of class learning activities. The episodes are built around 12 major environmental concepts that form a framework for each grade or subject area, as well as for the entire K-12 program. Further, each episode offers subject area integration, multi-disciplinary activities, where applicable, both cognitive and affective behavioral objectives and suggested reference and resource materials useful to the teacher and students.

1. This I-C-E guide is supplementary in design--it is not a complete course of study, nor is its arrangement sequential. You can teach environmentally within the context of your course of study or units by integrating the many ideas and activities suggested.

2. The suggested learning activities are departures from regular text or curriculum programs, while providing for skill development.

3. You decide when any concepts, objectives, activities and resources can conveniently be included in your unit.

4. All episodes can be adapted, modified, or expanded thereby providing great flexibility for any teaching situation.

5. While each grade level or subject area has its own topic or unit emphasis, inter-grade coordination or subject area articulation to avoid duplication and overlap is highly recommended for any school or district seeking effective implementation.

This total K-12 environmental education series is the product of 235 classroom teachers from Northeastern Wisconsin. They created, used, revised and edited these guides over a period of four years. To this first step in the 1,000 mile journey of human survival, we invite you to take the second step--by using this guide and by adding your own inspirations along the way.

PROJECT I-C-E TWELVE MAJOR ENVIRONMENTAL CONCEPTS

1. The sun is the basic source of energy on earth. Transformation of sun energy to other energy forms (often begun by plant photosynthesis) provides food, fuel and power for life systems and machines.

2. All living organisms interact among themselves and their environment, forming an intricate unit called an ecosystem.

3. Environmental factors are limiting on the numbers of organisms living within their influence. Thus, each ecosystem has a carrying capacity.

4. An adequate supply of clean water is essential to life.

5. An adequate supply of clean air is essential for life.

6. The distribution of natural resources and the interaction of physical environmental factors greatly affect the quality of life.

7. Factors such as facilitating transportation, economic conditions, population growth and increased leisure time influence changes in land use and population densities.

8. Cultural, economic, social, and political factors determine man's values and attitudes toward his environment.

9. Man has the ability to manage, manipulate and change his environment.

10. Short-term economic gains may produce long-term environmental losses.

11. Individual acts, duplicated or compounded, produce significant environmental alterations over time.

12. Each person must exercise stewardship of the earth for the benefit of mankind.

A "Concept Rationale" booklet and a slide/tape program "Man Needs His Environment" are available from the I-C-E RMC to more fully explain these concepts.

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E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

Environmental:

Integrated with:

CONCEPT NO. 1 - Energy

SUBJECT Science - Physics

ORIENTATION Energy Use

TOPIC/UNIT Radiant Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Conduct an experiment that gives evidence that the earth receives a finite amount of energy from the sun which can be measured in watts/CM^2. Calculate the amount of energy available from the sunlight for a given area.

Affective:

Discuss his awareness that a great amount of energy is available from the sun. Attempts to identify factors for which much research is needed if there is to be efficient utilization of the energy.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

Learning Activities:

1. Experiment: By measuring the area of a pan of water, its rate of heating in sunlight, the mass of water, the mass of the pan and the angle of sunlight, the student will calculate the power of the sun on the earth's surface in watts/CM^2.
2. Determine the energy requirements to supply a home with electricity, power an automobile, heat a home, etc. From these energy requirements and the calculated power of the sun on earth, determine how feasible it would be to utilize the sun's energy directly as a source of power.
3. Have individuals construct devices such as light-powered electric motor using a photo cell, which directly converts sunlight into energy.
4. A class discussion of ways to use the sun's energy directly.
5. Brainstorming session by small groups on how to use or conserve sun's energy.

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LFARNING ACTIVITIES

Publications:

Energy From the Sun by Daryl M. Chapin, Bell Telephone Laboratories. New York, New York, 1962.
(May be ordered, free of cost, at any Wisconsin Telephone Co. office.)
Physics - A Basic Science by Verwiebe, Van Hooft, and Saxon.
Weather Elements, Blair & Fite, Prentice-Hall, 1965.

Audio-Visual:

Films:
Energy, Steam and Progress, BAVI.
Laws of Conservation, of Energy and Matter, BAVI.
Filmstrip:
Energy Relationships - Ecology and Man Series, Set 1, McGraw-Hill.

Community:

NOTE: Maximum amount of power available from sun is 1.5 Hp./square yd.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 1 - Energy

SUBJECT Science - Physics

ORIENTATION Sun's Energy

TOPIC/UNIT Radiant Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Name two components of the atmosphere which affect absorption of radiations from the sun. Predict the sun's energy available to the earth's surface with given types and amounts of air pollution.

Affective:

Support organizations attempting to limit man's changing of the atmosphere given the opportunity. Discuss the effect of air pollution on the energy that is available from the sun to be used by plants and animals, etc. on earth.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Class experiment - two glass jars are fitted with thermometers and stoppers.
2. A drying agent such as $CaCl_2$ is placed in one and water vapor in the second.
3. Both jars are placed under a heat lamp and temperatures are recorded over a short time interval.
4. The procedure is repeated with one jar containing air and the second containing a high percentage of CO_2.
5. Temperature change rates are to be determined.
6. Discussion by students in small groups of the possible consequences of changing component percentages in the earth's atmosphere.

Discussion Points:

a. Glaciers melting, causing rise in sea level
b. Climatic changes
c. Possible extinction of some organisms

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Quarterly Journal - Royal Meteorological Society, '64, p. 223. Climate and Weather, Day and Sternes, Addison-Wesley Publishing Co., 1970. Weather and Climate: Problems and Prospects, National Academy of Sciences - National Research Council, 1966. **Audio-Visual:** Film: Spaceship Without a Skipper, MEC Center. **Community:**	

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Environmental:

Integrated with:

CONCEPT NO. 2 - Ecosystem

SUBJECT Science - Physics

ORIENTATION Energy Loss

TOPIC/UNIT Mechanics

BEHAVIORAL OBJECTIVES

Cognitive:

Calculate the loss of energy and the efficiency occurring in transfer of energy in an automobile from its engine to the kinetic energy of the entire body of the automobile using appropriate principles of kinetics. Compare and contrast the efficiency of engines using principles of graphing and appropriate data.

Affective:

Argue the position that transfer of energy has a direct relationship to pollution. Choose to operate vehicles in which there is the least loss of energy, given the opportunity.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Individual Research:
   Look up the body weight, the horsepower, and the 0-60 mph. acceleration time of a particular automobile. From this, calculate the ft.-lbs. of work done by the engine and the ft.-lbs. of energy gained by the car. From these two values, calculate the efficiency.
2. Data Analysis - (combine data)
   a. Use a graph to compare efficiency and horsepower.
   b. Use a graph to compare efficiency and body weight.

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Magazines such as: "Popular Science" "Popular Mechanics" "Auto Mechanics" "Industrial Arts Teacher" **Audio–Visual:** **Community:** Local Mechanic.	

Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Science - Physics

ORIENTATION Power Sources

TOPIC/UNIT Nuclear Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Predict the length of time that U^{235} will be available for nuclear reactor production of power by investigating figures on nuclear fuel reserves and trends of electrical usage. Calculate the cost of electricity produced by nuclear, water and coal used per fuel unit cost and efficiency of conversion.

Affective:

Recommend that new types of reactors or a change of power source must be developed if power production is to be adequate for the future during a discussion. Investigate other reasons for finding new sources of power other than availability.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Students would find and bring to class articles from newspapers and magazines pertaining to the size and number of nuclear plants in operation and proposed for the future.
2. Calculation of the number of years expectation until nuclear fuel is exhausted.
3. Student-led discussion of ideas pertaining to future power production or results of a failure in power production.
4. Visitation to a nuclear power plant at which time information can be obtained about the mass of fuel used per unit of electrical energy produced.

ADDITIONAL:

A.E.C. has cost/Kw-hr studies in pamphlet form to illustrate that Nuclear Power is cheaper (5-7¢/Kw-hr. cost).

(See pages 15-16)

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: America's Natural Resources, Gallison, Charles H., Ronald - 1967. Perils of the Peaceful Atom: The Myth of Safe Nuclear Power Plants, Curtis & Hogan, Doubleday, 1969. Natural Resources for U.S. Growth: A Look Ahead to the Year 2000, Landsberg, John Hopkins, 1964. Affluence in Jeopardy: Minerals and the Political Economy, Park, W. H. Freeman, 1968. Atomic Energy Commission pamphlets. **Audio-Visual:** Film: Radiation in Perspective, BAVI. Atomic Power Production, BAVI. **Community:**	

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ELECTRIC LIVING - THE POWER COST OF APPLIANCES

The table can tell you the approximate operating cost of nearly 50 electric appliances in houses. The figures are from a national survey by the Edison Electric Institute, the electric companies' trade association. They are average figures for typical use of each appliance.

The first column gives the power drain by each appliance when it is turned on. It's the same standard unit of electric power, the watt, used for electric light bulbs, electric motors, and other electric devices. A heating pad, for example, draws 60 watts of power and therefore uses the same quantity of electricity as a 60-watt bulb.

The second column is more indicative of operating cost. It gives the total average electricity commonly used by each device in a year. Divide any figure in this column by 12 to get monthly average power consumption. Thus, a dishwasher will use about 30 kilowatt hours of electricity a month.

Electrical Appliance	Average Power Required, Watts	Average Total Power in Kw. Hrs. Consumed Annually
Air conditioner, room	1,485	750-1,500**
Air conditioning, 3-ton central*	4,500	3,000-6,000**
Blanket, electric	180	145
Broiler	1,430	110
Clock	2	17
Clothes dryer*	4,695	965
Coffee maker	910	100
Deep-fat fryer	1,420	85
Dehumidifier	265	350
Dishwasher	1,200	360
Egg cooker	510	14
Fan, attic	370	285
Fan, circulating	90	45
Fan, furnace	280	400
Fan, roll-about	185	130
Fan, window	190	165
Floor polisher	315	15
Food blender	345	14
Food freezer, 15 cu. ft.	335	1,120
Food freezer, frost less, 15 cu. ft.	425	1,685
Food mixer	125	12
Food-waste disposer*	420	25
Frying pan	1,180	190
Germicidal lamp	20	11
Grill, snadwich	1,150	35
Hair dryer	235	11
Heat lamp, infrared	250	14
Heat pump*	12,075	15,750**
Heater, radiant	1,320	175
Heating pad	60	9

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Electrical Appliance	Average Power Required, Watts	Average Total Power in Kw. Hrs. Consumed Annually
Hot plate*	1,260	90
Humidifier	115	150
Iron, hand	1,085	150
Iron, mangle	1,465	165
Knife, carving	90	3
Oil burner or stoker*	260	410
Radio	80	90
Radio-phonograph	115	110
Range*	12,140	1,160
Refrigerator, 12 cu. ft.	240	675
Refrigerator, frostless 12 cu. ft.	310	1,040
Refrigerator, freezer 14 cu. ft.	330	1,085
Roaster	1,330	215
Sewing machine	74	11
Shaver	14	3
Sun lamp	280	16
Television, black and white	250	345
Television, color	330	450
Toaster	1,140	40
Tooth brush	9	5
Vacuum cleaner	600	45
Vibrator	40	2
Waffle iron	1,095	20
Washing machine, automatic	515	105
Washing machine, non-automatic	285	88
Water heater, standard*	2,430	4,170
Water heater, quick recovery	4,475	4,600
Water pump	435	225

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Environmental:

Integrated with:

CONCEPT NO. 4 - Water

SUBJECT Science - Physics

ORIENTATION Waste Disposal

TOPIC/UNIT Nuclear Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Calculate the total water needed for safe disposal for a given amount of a radioisotope resulting from electrical generation using the amount of water as specified by Government standards for dilution of a radioisotope sample.

Affective:

Argue, during a discussion, that there is a need for re-evaluation of radioisotope disposal methods which use water, in order to conserve the water for other uses important to mankind. Weigh alternative methods to the water disposal method for radioisotopes.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Pre-lab discussion:
   The students should know they are being given a solution which contains 6 grams thorium nitrate, and it will be their job to perform the experiment and dispose of the radioactive material at the end. Each student should go to a Chart of the Nuclides and trace the Th^{232} down to non-radioactive Pb^{208}, noting the half-lives of each isotope. The extremely long half-life of Th^{232} should prove to the students that they cannot wait for it to become stable, so care must be used in disposing of it. From the specific activity, the mass of thorium in thorium nitrate and the Federally allowed concentration of Th^{232} radiation in water, calculate the amount of water needed to dilute this amount of thorium nitrate to dispose of it.

(Continued)

Outside or Community:

SUGGESTED RESOURCES

Publications:

Project Physics Handbook Unit 6. Experiment 46 Half-life I, C. Short Lived Radioisotopes, Holt, Rinehart & Winston, N. Y., 1968.
Project Physics Teachers Guide, Unit VI, p. 83, Holt, Rinehart & Winston, New York, 1968.
Code of Federal Regulations, CFR Title 10, Atomic Energy, Chapter 1, part 20, Government Printing Office, Washington, D.C.

Audio-Visual:

Chart of the Nuclides can be obtained free of charge from Educational Relations, General Electric Company, Schenectady, New York, 12305.
Film: Radioisotopes: Tools of Discovery, BAVI.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

The Experiment:

The student will perform the experiment as directed. The counting should continue until the net counting rate is nearly down to zero, although the data taken after 10 minutes will be useless for half-life determination. Allowing the counts to go to zero should prove to the student that he can safely dispose of the separated isotope in the trash.

Discussion:

Students will discuss the use of water as a dilution agent and the possible ecological consequences.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 5 - Air

SUBJECT Science - Physics

ORIENTATION Air Pollution

TOPIC/UNIT Electrostatics

BEHAVIORAL OBJECTIVES

Cognitive:

Constructing a model smoke precipitator and demonstrate its use, describing problems of operation, in illustrating the principle of electrostatic precipitation as a method for removing particulates from smoke.

Affective:

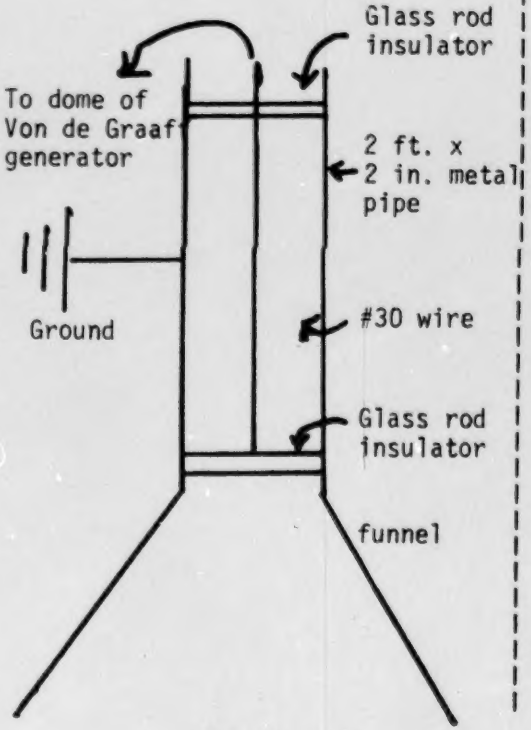
Indicate his acceptance of the need for installation of air pollution control devices by discussing with positive attitude, the questions of pollution control costs vs. environmental costs resulting from pollution damage.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. This will be a special project for one student or a small group of students. A smoke precipitator can be constructed as follows:



Outside or Community:

(Continued)

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SUGGESTED RESOURCES

Publications:

Electrostatic Precipitators, McGraw--Hill Encyclopedia of Science and Technology, McGraw-Hill Book Co., New York, 1960, p. 538.
Demonstration Experiments in Physics, A-5 Smoke Precipitation, McGraw-Hill Book Co., 1938, p. 434.
Clifford E. Swartz, Physics and All That Garbage, The Physics Teacher, 8, (Nov. 1970), p. 421.
Also, look up Cottrell process in any encyclopedia.

Audio–Visual:

Film:
City Fallout - Modern Talking Picture Service, Inc.
Electricity: How It Is Generated, BAVI.
Simulation Game:
Smog, The Air Pollution Game, Urban Systems, Inc.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

In-Class: (Continued)

Smoke should preferably be made by putting bottles of hydrochloric acid and ammonia near each other, producing ammonium chloride. Wood or cigarette smoke can be used but not as well. When the Von de Graaff static electricity generator is turned on, a corona discharge takes place near the wire, and the ions produced, attach themselves to the smoke particles. The smoke particles are drawn to the electrodes, leaving nearly clear air. While this device is simple in theory, it is much more complicated when put into practical use, and this should be emphasized in the student's oral presentation.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 5 - Air

SUBJECT Science - Physics

ORIENTATION Energy Use

TOPIC/UNIT Electricity

BEHAVIORAL OBJECTIVES

Cognitive:

Record the electrical energy used in his home during a given period of time. Determine the amount and cost of electrical energy used by each of the electrical devices in his home. Determine which devise(s) could have its use limited without causing hardship or reducing safety.

Affective:

Accumulative effect of each individual's wastefulness and contribution to pollution through power production. Become the "watch dog" of power in his own home consumption in order to reduce its use to a realistic minimum for his household. Challenge others in his home to reduce the electricity consumption due to non-needed usage to a minimum, i.e. turn off lights when not needed, etc.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Each student will compute the total kilowatt-hours of electrical energy used in a 24 hour period from the rated wattage of each electrical device in his home and the approximate time in use. Each student is to compare his total with the increase in kilowatt-hours shown on his kilowatt-hour meter over this period.
   NOTE: A fairly accurate method of obtaining the kilowatt-hours in heating water is to estimate the gallons of hot water used, and from this and the temperature rise, compute calories. Then convert calories to kilowatt-hours.

Interpreting results:

- -By what percent could you cut your energy concumption without really lowering your standard of living?
- -What percent of the electrical energy in your home do you think is wasted through careless use?
- -Extrapolate total wasted energy to community and nation.

Outside or Community:

(Continued)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: The Atmosphere and the Sea in Motion, Bolin, Rockefeller Inst. Press, 1959. Physics - A Basic Science, Verwiebe, Van Hooft & Saxon. Pamphlets on air pollution - EPA. **Audio-Visual:** **Community:** Data from local power generating utility.	In-Class: (Continued) -From data obtained from local generating plant, calculate the amount of fossil or nuclear fuel that is used to produce the wasted energy in above activity.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 5 - Clean Air is Fss.

SUBJECT Science - Physics

ORIENTATION Air Pollution

TOPIC/UNIT Ionization - Air

BEHAVIORAL OBJECTIVES

Cognitive:

Collect and observe, qualitatively, the particulate matter carried by air. Calculate the amount of particulate matter that settles out of a given sample of the air. Make predictions on the amount of particulate matter in the air above a given area, using the information obtained from the samples.

Affective:

Searches for sources of vast amounts of particulate matter carried by the air. Investigates air to determine what constitutes the particulates that are present.

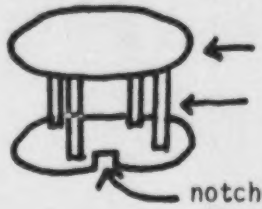
Skills Used:

Sampling techniques.
Sampler construction.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

Construct a Durham sampler, using 2 14" discs of cardboard separated by 4 wood dowels (see drawing).



A slide attached by means of a spring clothespin and covered with petroleum jelly is the collector.

After a suitable time interval, the slide is removed and observed beneath the light microscope or binocular scope.

The particulates will be composed of ash or soot particles, pollen, and fibers. All can be identified by use of the light microscope.

Outside or Community:

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SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: **Audio–Visual:** University of Wisconsin - Oshkosh E.M.C. Slide, script presentation, Particulate Matter in Air, by W. Poupore & R. H. Conradt. **Community:** DNR regional air quality monitoring official. (Contact nearest DNR office to get name.)	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 6 - Resources

SUBJECT Science - Physics

ORIENTATION Power

TOPIC/UNIT Electricity

BEHAVIORAL OBJECTIVES

Cognitive:

Calculate the power loss as electricity is moved along high voltage power lines. Explain the relationship between wire size and power loss due to friction. Explain how wire size affects the amount of power available for useful work.

Affective:

Gather additional information that illustrates the need for other than hydrological power generation stations and the possible pollution problems caused by them. Choose to pay a higher price for those electrical generation stations contributing the least pollution if given the opportunity.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Visitation of a hydro-power generating station at which power output, line voltage, amperage, wire size and material information is obtained. (Questions to be asked of the station operator should be submitted by the class in advance.
2. Using information obtained at a power plant, the class can calculate the power loss per mile of transmission line using $R = C\ L/A$ and $P = I^2R$. Power loss can be related to efficiency and cost.
3. Using information obtained at a power plant, the class can calculate the power needed in United States for the years 2000 and 2150.

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Physics: A Basic Science, Verwiebe, Van Hooft, and Saxon, American Book Company. Handbook of Chemistry & Physics. **Audio–Visual:** Film: Electromagnetic Induction, BAVI. **Community:** Local utility company rate schedules. Speaker from local utility company for discussion of other means of power production for local consumers and the possible pollution effects of each type of generator.	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 7 - Land Use

SUBJECT Science - Physics

ORIENTATION Land Use

TOPIC/UNIT Nuclear Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Find and record the amount of land and the changes of land usage occurring when the land was designated for atomic energy development by examining reference materials. Explain the disadvantage of atomic power generation in terms of land usage.

Affective:

Demonstrate alertness to continued changes in land usage by bringing to the attention of his classmates any changes having serious consequences on the environment for purposes of discussion and possible action.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. The student can find many references to the development of atomic devices starting with publications of 1943. He should find these articles and record in chronological order the places that have been used, the areas of each and the previous use of the land. He can then total the amount of land devoted to changes caused by use for atomic energy.
2. Discussion by students of their findings and of the values of atomic energy development versus the effects on the land usage.

Outside or Community:

*This exercise is suitable mainly for out-of-class research at public libraries, university or college libraries or resource material centers that would have copies of or microfilm of the publications noted.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

Magazines students could use:
Science news Letter, 8/28/43
Life, 9/24/45
Atlantic Monthly, 11/46
Forum, 10/45
Flying, 11/46
Congressional Digest, 5/46
Time, 1/28/46
Nation, 8/3/46
Science News Letter, 9/22/45
Time, 2/18/46
Business World, 8/3/46
U. S. News & World Report, 2/1/46

Audio-Visual: (Continued)

Introducing Atoms and Nuclear Energy, 16 mm film.
Mankind and the Atom, 16 mm film.

Community:

Field trip to Point Beach Nuclear Plant or guest speaker from there.

Publications: (Continued)

Newsweek, 2/18/46
Science News Letter, 12/22/45
Science News Letter, 12/21/46
Life, 2/12/51 and 9/12/49
Newsweek, 7/3/50
Time, 7/21/52
Science Digest, 7/52
Scientific American, 12/52
U.S. News & World Report, 3/26/54
Discussion, 7/53
New Republic, 7/26/54
Science News Letter, 3/20/54
Time, 5/62
Atomic Energy pamphlets, series by the Atomic Energy Commission.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 7 - Land Use

SUBJECT Science - Physics

ORIENTATION Land Use

TOPIC/UNIT Momentum

BEHAVIORAL OBJECTIVES

Cognitive:

Explain the way that technological advancements such as the jet engine have a vast impact upon the environment.

Affective:

Reserve judgement as to the value of the development of new technology until he has obtained information about its longrange effect on the environment. Suggest to others that they reserve their judgement on the value of a technological development until they have enough facts about the longrange effect (Cont.)

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

As a culminating activity following an experiment on momentum, discuss the role of jet propulsion and space travel in modifying land uses and influencing population density.

Additional discussion might evolve concerning the development and design of airports, and the immense area of land used in their construction. Could the land be better used for agriculture or recreation? Should airports be so large?

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Fundamentals of Ecology, Odum. W. B. Saunders Co., pp. 449-450. **Audio–Visual:** Films: ABC of Jet Propulsion, BAVI. Apollo II For All Mankind, BAVI. Research by Rockets, BAVI. **Community:** Planning commission members. Landscape engineering consultants.	Affective: (Continued) on the environment.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 8 - Values and Attutudes **SUBJECT** Science - Physics

ORIENTATION Careers **TOPIC/UNIT** Scientists

BEHAVIORAL OBJECTIVES	STUDENT–CENTERED LEARNING ACTIVITIES	
	In-Class:	**Outside or Community:**
Cognitive: List several career opportunities for physicists that are increasing and those that are decreasing in number. Explain factors and criteria that should be used in determining a career to be chosen for a person's livelihood.	1. Compilation of the data that members of the class have obtained from the outside resources. 2. Analysis of their information in relation to causes which may come from cultural, economic, social, and political factors. 3. Visitation and interview of university personnel. 4. Visitation and interview of industrial personnel. 5. Visitation and interview of employment agency personnel. 6. Classroom presentation by school's guidance counselor.	
Affective: Re-evaluate his own career intentions based on awareness of the changing employment opportunities. Weighs alternative careers available to himself in light of present opportunities and his interests and abilities.		
Skills Used:		

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Engineering Journal. Physics Today. Local newspapers. Any scientific journals including "Help Wanted" ads as part of their format. **Audio–Visual:** Movie: #6066 - Careers in Engineering, $4.00, BAVI, 1968. **Community:** Local university. Local industries. Employment agency.	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 8 - Values and Attitudes **SUBJECT** Science - Physics

ORIENTATION Noise Pollution **TOPIC/UNIT** Sound

BEHAVIORAL OBJECTIVES

Cognitive:

Define terms commonly used when referring to sound and, more specifically, noise pollution. Predict what the long range effect on a person subjected to a given noise level for a period of time:

a: physical
b. psychological

Affective:

Investigate types of damage that some sounds can produce in humans and other animals. Work to control the noise pollution problems in his own environment through identification and formulation of a plan to reduce the noise or the effects of the noise.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Measure areas and intensity of noise. (A decimeter can be borrowed if not available.)
2. Students should learn the definitions of some unfamiliar terms:
   a. Intensity of sound
   b. Threshold of hearing
      10^{-16} watts/cm^2
   c. Threshold of pain
   d. Degree of loudness
   e. Decibel
3. Sample Problem: Taken from Modern Physics, Williams, Metcalfe, Lefler.
   a. Sound energy is radiated uniformly in all directions from a small source at a rate of 1.2 watts.
      1. What is the intensity of sound at a point (2500Ocm) 25 meters from the source?
      2. What is the intensity level?

(Continued)

Outside or Community:

SUGGESTED RESOURCES

Publications:

U.S. News & World Report, Sept. 23, 1963, p. 64.
Science World, Feb. 9, 1970, p. 8.
Milwaukee Journal, June 29, 1971.
Health, Winter, 1970, p. 20.
Our Sunday Visitor, Mar. 21, 1971.
Decibel Dynamite.
Changing Times, March,'71, p. 33.
Sunday Post Crescent (Appleton, Wis.) Nov. 8, 1970, p E-3.
Newsweek, Feb. 7, 1972.
Science Digest, June, '68, pp 67-8.
Time, Aug. 9, 1968, p. 47;

Audio-Visual: (Continued)

Filmstrip:
Visual Education Consultants, Inc.
Noise Pollution, #3013,
From NET, Indiana University AV Center, Bloomington, Ind. 47401.
Film:
Noise: The New Pollutant.
Noise is Pollution, Too, BAVI.
Noise Presentation,
Modern Talking Picture Service, Inc.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

In-Class: (Continued)

3. b. Solutions:

1. $I=\frac{P}{A} = \frac{1.2W}{4\ (2500)^2} = \frac{1.2}{7.85\times10^{8}} = 1.5\times10^{-8}\ w/cm^2$

2. $10 \log \frac{I}{I} = 10 \log \frac{15\times10^{-8}}{10^{-16}} = 10 \log (1.5\times10^{8})$
$= 82$ decibels

4. Teacher-student discussion.
   a. Encourage students to have hearing examinations.
   b. Encourage students to keep the community aware of noise pollution.
   c. Press for laws which control noise pollution.
   d. Continue to be conscious of the effect of noise pollution on "quality of life" and encourage students to avoid needlessly adding to noise pollution in the community.
   e. Keep students aware of injury (probably permanent) to their ears. Loss of hearing due to excessive noise is real.
   f. Find a table of intensity levels of various sounds. Compare these sounds.
5. Check with factories and find out what problems they have with excessive noise. Ask what they have been able to do to control it.
6. Ask someone from the factory, foundry, etc., to explain the type of injury (permanent or temporary) which a person can sustain from excessive noise.
7. Check with someone from Workman's Compensation Ins., a doctor, etc., on the extent and seriousness of the problems of sound pollution.
8. Formulate a questionnaire and have the students use it with their neighbors to find out what kind of noises bother them most in the neighborhood.

Publications: (Continued)

Science Digest, Oct.,'68, pp. 63-4.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 9 - Management

SUBJECT Science - Physics

ORIENTATION Technology

TOPIC/UNIT Mechanical Forces

BEHAVIORAL OBJECTIVES

Cognitive:

The student will learn that the impact of construction on the environment goes far beyond the intended purpose of the structure.

Affective:

The student will be more aware of the consequences of proposed construction projects and will be better able to evaluate their desirability.

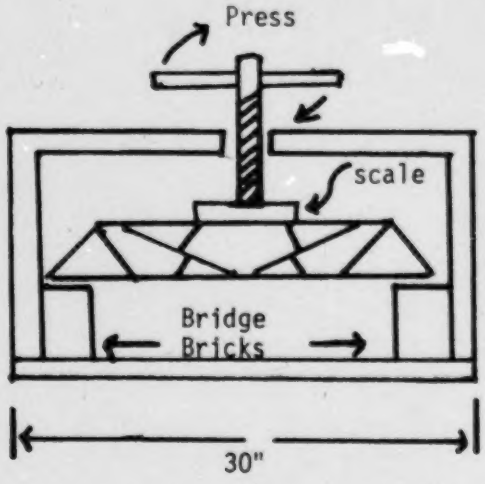
Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

Hold a bridge building contest. Supply each student (or group of students) with the same amount of balsa wood strips and glue.

The purpose is to build the strongest bridge for a given span. The bridges can be tested for strength by constructing a press utilizing a bathroom scale. Discuss the impact of bridges upon the environment.



Outside or Community:

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SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: The University of Wisconsin School of Engineering has informational pamphlets which they will send you relative to building such a bridge structure. They sponsor a contest yearly in which they encourage sound structural design. Students build them from balsa. The winner receives a scholarship for Engineering school at Madison, Wis. **Audio–Visual:** Film: Bridge is Born, 28 min., BAVI. **Community:**	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 10 - Economic Planning

SUBJECT Science - Physics

ORIENTATION Effects of Radiation

TOPIC/UNIT Nuclear Energy

BEHAVIORAL OBJECTIVES

Cognitive:

Explain how radiation can produce changes in organisms and in future generations of these organisms. Identify radiation as the probable cause in structural change of an animal or plant that has been irradiated.

Affective:

Argue a position that although nuclear energy can provide definite benefits for our economy, many dangers to living organisms exist in its use, therefore, definite controls are necessary. Insist that radiation materials be handled in accordance with precautions put forth by the Atomic Energy Commission, when using in the lab, even though this requires more time and is sometimes awkward.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Plant irradiated oat or corn seeds a month before the lesson. Put each seed into a separate container of sterilized soil. You may also want to plant a group of control seeds.
2. Note at intervals the differences in growth pattern and anatomical variations.
3. Discussion:
   a. Benefits of nuclear energy (power, radioisotopes, etc.)
   b. Mutations produced by radiation
   c. Transmission to future generations
   d. Specific effects on humans including future generations (99% of all mutations are harmful).
   e. Sources of radiation (natural, fallout, food, etc.).
   f. Controls necessary in the use of nuclear energy.

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: EPA Publications - Radiation. Nuclear Power Plants - Questions and Answers. Never Do Harm. People and Their Environment - Teachers' Curriculum Guide to Conservation Education (Biology), J. G. Ferguson Publishing. **Audio-Visual:** Films: Atomic Radiation, BAVI. Nuclear Radiation--Fallout, BAVI. Nuclear Radiation--Uses in Industry, BAVI. Atomic Power Today--Service with Safety, National Audio-Visual Center, Washington, D.C. **Community:**	

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Environmental:

Integrated with:

CONCEPT NO. 11 - Individual Acts

SUBJECT Science - Physics

ORIENTATION Air Pollution

TOPIC/UNIT Light

BEHAVIORAL OBJECTIVES

Cognitive:

Explain that particulate matter scatters light energy, particularly the shorter waves of the spectrum. Predict the amount of reduction in energy to the earth as a result of a given amount of air pollution.

Affective:

Deduce that the accumulation of particulate matter in the air of over a long period of time has a detrimental effect upon the environment. Use a demonstration to convince others of the effect of particulate matter in air on the amount of energy reaching the earth.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

Examine the scattering of light by particulate matter in the atmosphere. A parallel beam of white light from a carbon arc and level L_1 is sent through a water trough with glass sides. After passing through iris diaphragm at the other end, a second level L_2 forms an image of the circular opening on the screen. To produce the fine particles for scattering, about 40 g. of photographic fixing powder (hyposulfite of soda) are added and the contents thoroughly mixed in the trough.

As the microscopic sulfur particles begin to form, scattered blue light will outline the parallel beam through the trough. A little later, when more particles have formed, the entire body of water will appear light blue, due principally to multiple scattering. Light scattered out of the central beam is scattered again and again before emerging from the trough. At first, the transmitted light appears white on the screen.

(Continued)

Outside or Community:

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SUGGESTED RESOURCES

Publications:

College Text, Modern College Physics, Harvey E. White, pp. 400-402.

Air Pollution pamphlets, EPA.

Audio–Visual:

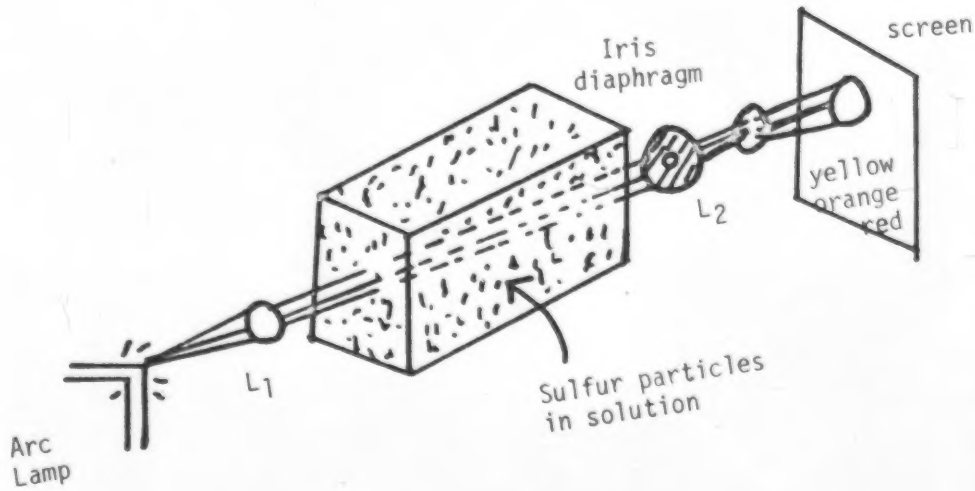
Film:
Air Is For Breathing, Shell.
To Clear The Air,
Wisconsin Petroleum Council
25 W. Main Street
Madison, Wisconsin 53703.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

In-Class: (Continued)

Later, as more scattering takes out the shorter wavelengths, this image representing the sun turns yellow, then orange, and finally red.



Discuss the possible consequences of this effect in terms of the huge amounts of particulates constantly entering the atmosphere.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 12 - Stewardship **SUBJECT** Science - Physics

ORIENTATION Water Pollution **TOPIC/UNIT** Light

BEHAVIORAL OBJECTIVES

Cognitive:

Calculate ratios on local area maps of water turbidity using a light meter. Identify causes of the turbidity in local bodies of water.

Affective:

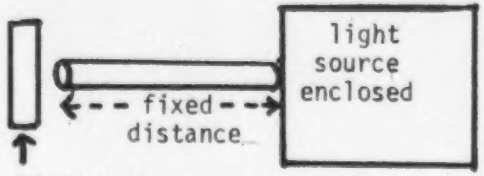
Demonstrate alertness to uses of stream water that may add to its turbidity by identifying several in his community, given an out-of-class assignment to observe local bodies of water. Support those activities that will reduce turbidity already present.

Skills Used:

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. The students will construct a tube that can be used as a water sampler. The tube is to be transparent at both ends.



2. The first reading is to be taken in the classroom using any available high power light source, distilled water, and a light meter normally used for photography.
3. At a nearby stream that flows through an extensively used area, the students collect samples at sites along the length of the stream. If a map is available, the sample locations should be identified on the map.

(Continued)

Outside or Community:

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SUGGESTED RESOURCES

Publications:

The Principles of Light and Optics, R. A. Wheadon; Longmans, Green and Company Ltd., 1968.

EPA Publications on water pollution.

Audio-Visual:

Local Area Maps.
Films:
The River Must Live, Shell Oil Company.
It's Your Decision - Clean Water, Modern Talking Picture Service, Inc.
Light: Illumination and Its Measurement, BAVI.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

In-Class: (Continued)

4. Each sample is placed on the tube and the light meter reading used to calculate a ration of transmitted light compared to that of distilled water.
5. Students attempt to hypothesize the causes of any changes in the meter readings making use of the known activities taking place along the stream.
6. Have representative of local industry - making use of stream for disposal of used water.